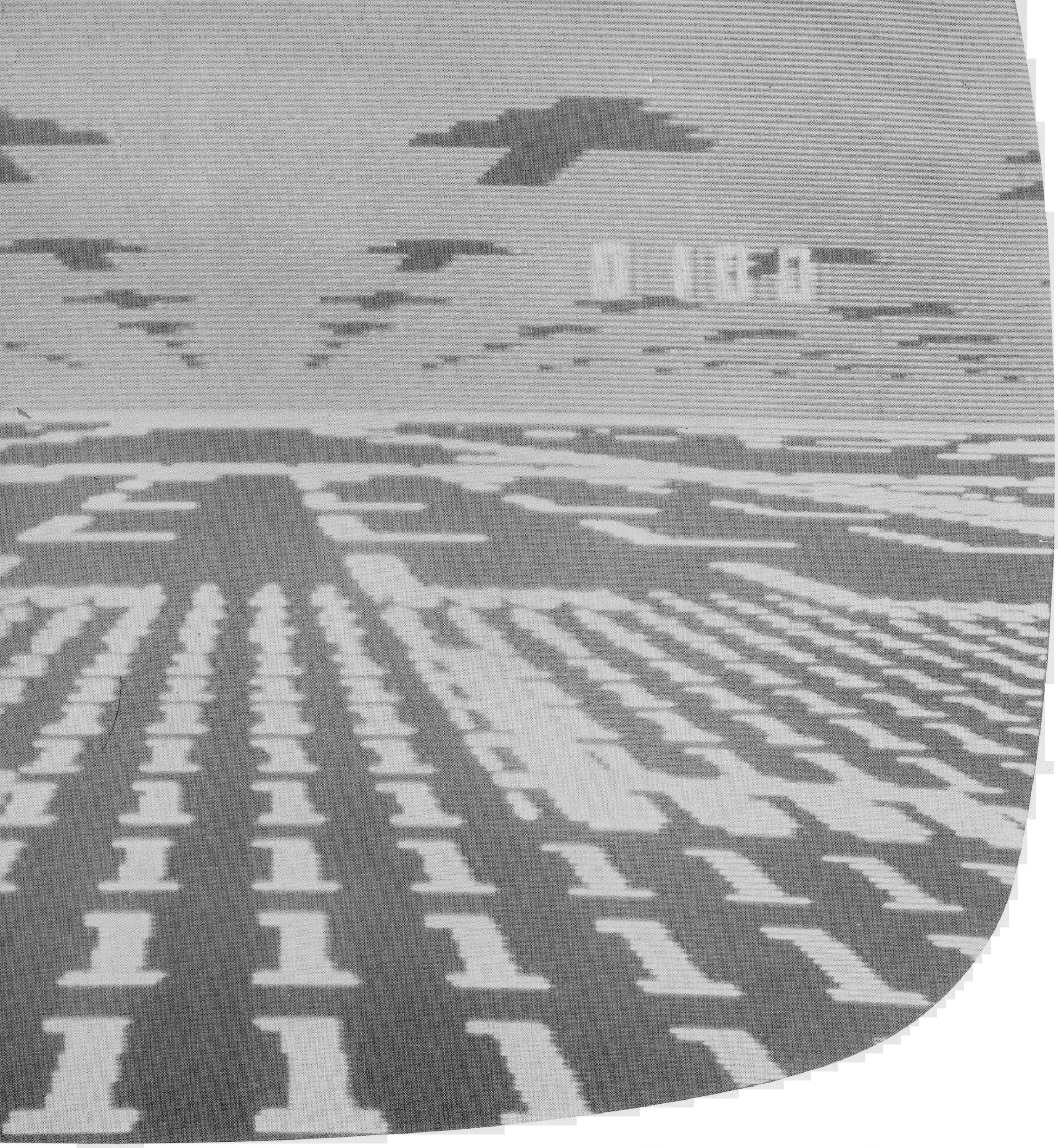

COMPUTER EVALUATION OF INTEGRATED SYSTEMS

At the Naval Missile Center, Point Mugu, information on the behavior of guided missiles is obtained in several ways, one of which involves the use of computers to simulate parts of the weapon system. Components of the system are joined to analog and digital computers that replace unavailable parts. Programmed with mathematical statements describing these parts, the computers interact with the "real" components to form the complete system. These statements can be comparatively simple ones that might describe the action of a piston in a cylinder, or they can be extremely complex, describing a whole weapon system including jet aircraft, radar, and guided missiles. Computer descriptions of such a system would include information on how the missile flies, the aerodynamic forces involved, its velocity and position at a particular time after launch, how its fuze works, how powerful the warhead is, and aerodynamic factors about the probable target.

The tests performed in this way are non-destructive, controlled, and comparatively inexpensive. The answers they provide not only supplement those obtained by flight tests but may actually substitute for them in cases where flight tests are limited by cost, the availability of actual parts, and time, as well as when flight tests are impractical.

Unique to computer evaluation is the ability to reproduce a certain kind of mission–for example, a flight against a particular target at a certain altitude at certain speeds under specific conditions. This ability enables the Missile Center analysts to predict the performance of the real system readily and completely and in a greater variety of situations and environments than is normally permitted by flight tests. They can answer such questions as: Where will the missile be when the fuze ignites? Where will the target be then? How effective will the warhead be at that distance and angle? Combining this knowledge with studies of the intended target, they can estimate the lethality of the weapon.

To obtain significant answers, the entire weapon system must be studied as a unit, including the launching aircraft, the target, and the missiles, and also man himself. For this reason, a cockpit mockup has been designed and built at the Missile Center that enables a pilot and a missile-control officer to

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function as parts of the complete, simulated system. Because various aircraft characteristics can be simulated by the cockpit mockup, concepts for new weapon systems can be evaluated during their formulation and the interaction of the parts of the proposed system can be studied. Such a simulator also makes it possible to train aircrews in the use of the aircraft–both before and after it is built.

A more sophisticated test complex has been installed at the Naval Missile Center to test the F-14A/Phoenix weapon system. It is one of the major tools used by the contractor in developing the avionics integration for the F-14A aircraft, and will later be used by the Naval Missile Center for test and evaluation of the weapon system. The test complex is composed of parts of the missile control system such as the radar, digital computer, controls, and display panel, plus other equipment necessary to simulate the rest of the weapon system. Seated in the laboratory cockpit, the pilot and missile-control officer will be able to "fly" a mission that will be realistic in all respects except for the feeling of aircraft motion. Looking at their radar scopes, they will see simulated targets moving in, and the missile-control officer can "launch" the missiles and his success can be measured.

Another project at the Naval Missile Center using simulation equipment involves joint Army-Navy analyses and experiments to improve the interaction of aircrewmen with their aircraft by improving ways of displaying information within the cockpit. Facilities used in this project include a static fixed-wing cockpit, a dynamic six-degree-of-freedom moving-base cockpit simulator, computers, a display-generator to drive the cockpit displays, and a system for scoring the performance.

Representative computer simulation tasks performed at the Naval Missile Center have included: research studies of air-frame, autopilot, and propulsion for missiles under design; assistance to contractors in designing and evaluating autopilot and seeker systems; determination of permissible firing envelopes and optimum trajectory parameters for air-to-air missiles; investigations of launch parameters, range safety criteria, and recovery trajectories for tactical probes and satellites; and evaluation of production-model, command-guidance computers.

① Each strip-chart recorder at the right can continuously record the progress of up to eight variables simultaneously. ② The general-purpose computer laboratory supports such projects as Sparrow III, AIM 7-2E, and AIM 7-F simulation investigations, and the F-4B intercept-simulation tests. Several studies have been conducted in electronic warfare involving simulated threats from Southeast Asia, plus some simulation testing in support of laser projects. In this simulation laboratory, a missile component or a whole system can be coupled with the computers and a complete operation "flows" electronically. By this method, it is possible to determine how a system will perform under given circumstances without subjecting the system to the hazards and expense of launch and flight. Some of the systems tested exist only on the drawing board, and their practicality can be evaluated before time and money have been spent on development of a prototype. ③ The data acquisition system records digitally, information on test parameters and system performance. Tapes are used for direct playback into data processing computers for data reduction. The process speeds up handling of raw test data and eliminates human errors once the data reduction program has been validated. ④ In this facility, personnel evaluate the compatibility of displays and controls with the human component. At

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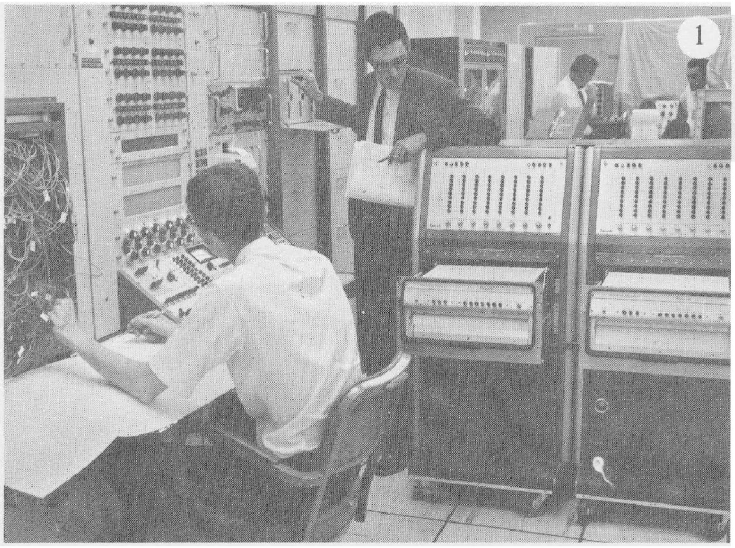
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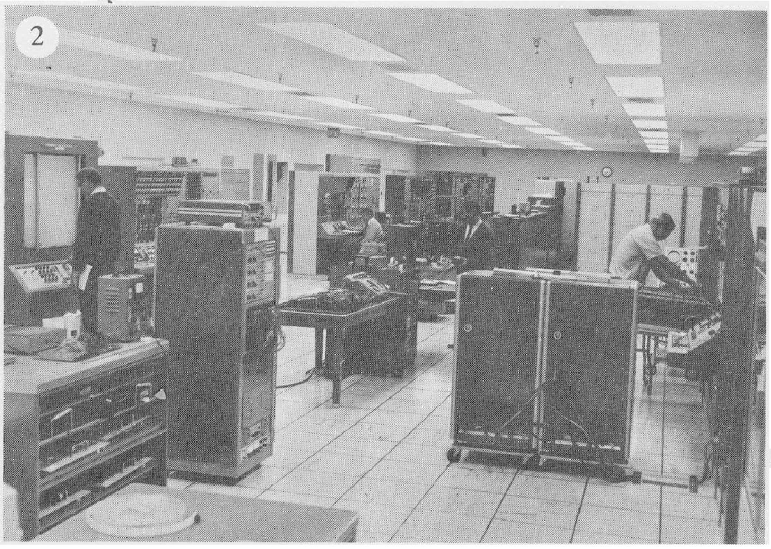
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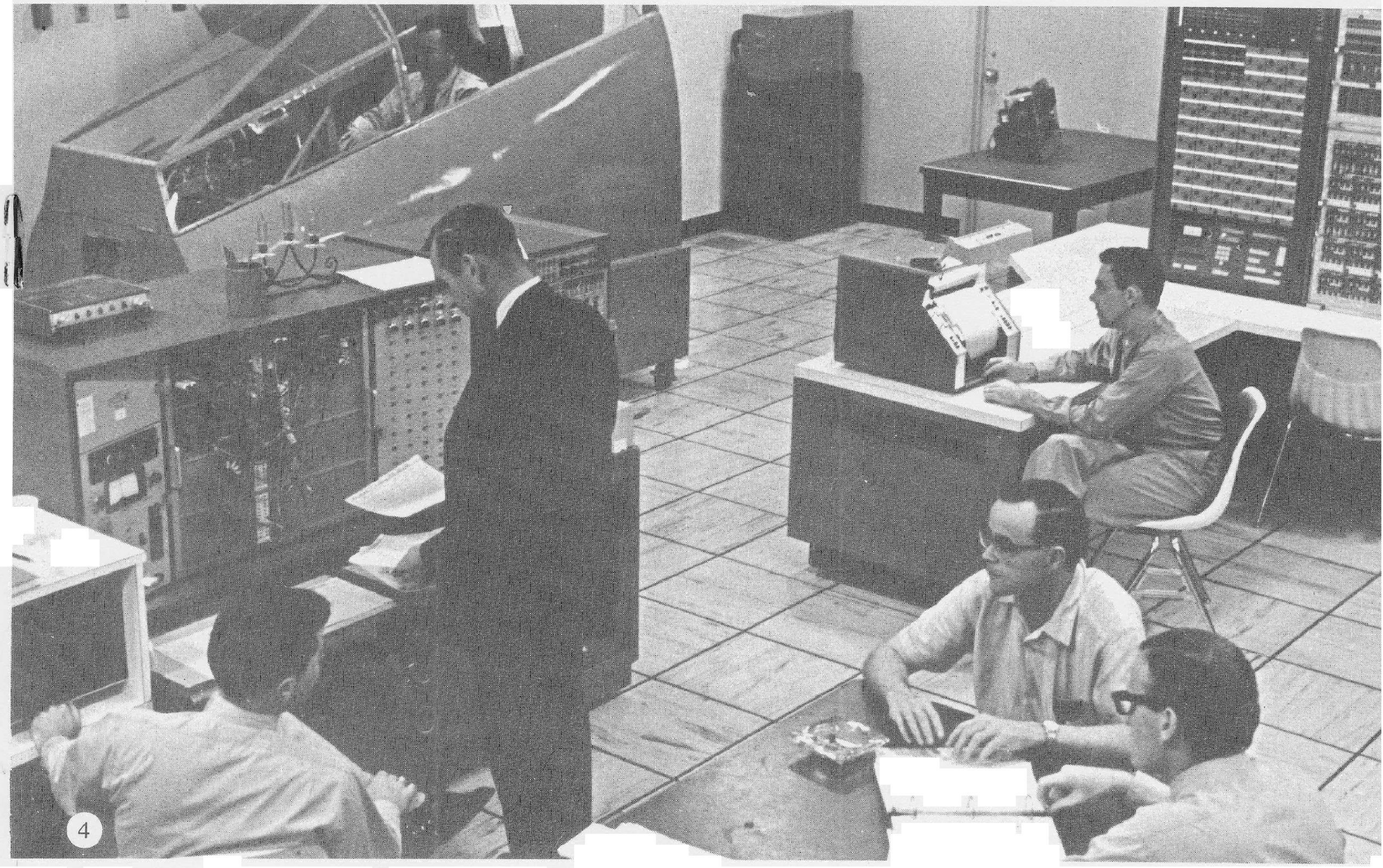
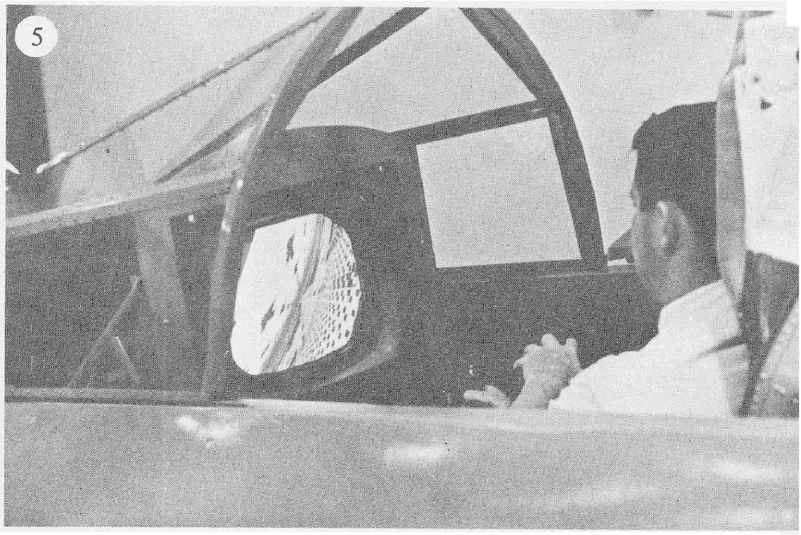
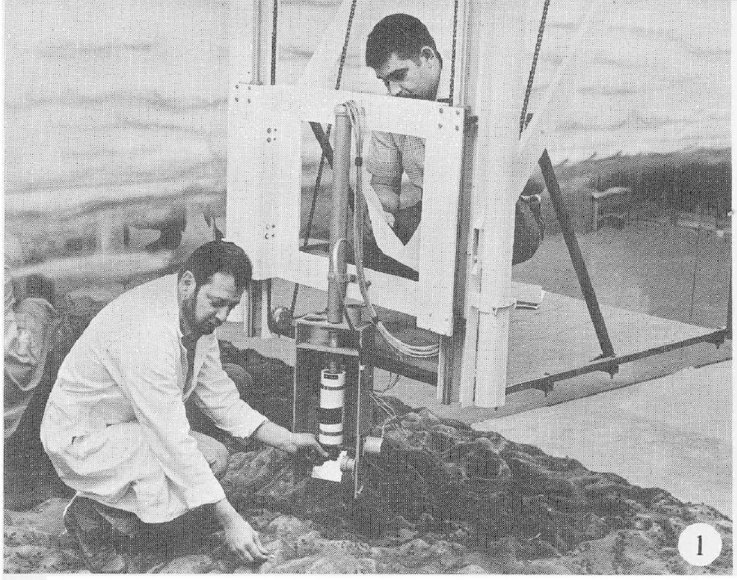


the left is a general-purpose cockpit, and general-purpose analog computers are at right and left. ⑤ In the general-purpose cockpit simulator, a "pilot" views a computer-made picture that shows changes in the relationship between the aircraft and the world outside. This single focus point for the pilot serves where previously several were required. The picture is made by a computer that continuously obtains information from sensors such as altimeters, true-speed indicators, and turn-back indicators. The computer performs at the rate of thirty changes per second, and the changes are pictured on a cathode ray tube. The picture alone may well be equal to or better than all the instruments that clutter the conventional cockpit.

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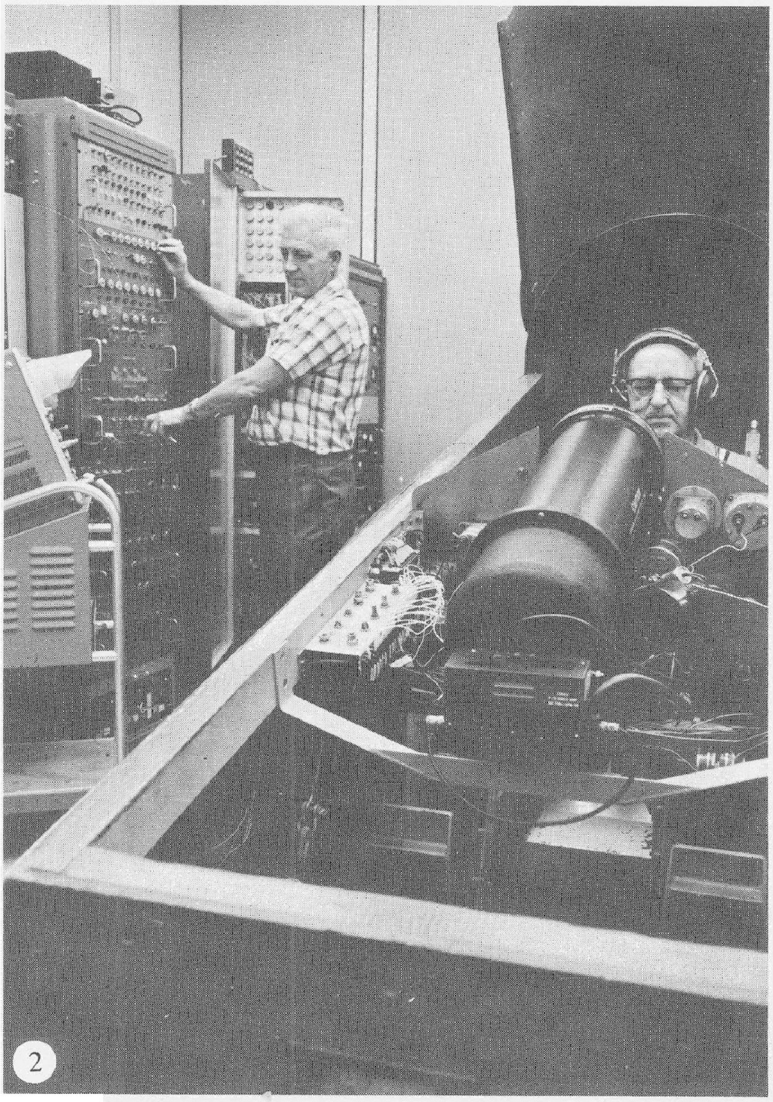
①The terrain model is an electro-optical simulator used in the investigation of air-to-surface weapons that use electro-optical sensors. The terrain model consists of modular blocks that can be rearranged to fit the terrain to be simulated. Currently, only static tests can be conducted. However, a computer-controlled system, now under construction, allows motion in any direction, thus making dynamic simulation possible. ②This cockpit simulator is used for man-machine experiments and for checking out the aircraft computers. ③The AN/AWG-10 missile facility uses system hardware mounted on a bench that can move on tracks. During laboratory tests, it is used in the shielded room, but for ground-to-air tests, the bench is moved to a balcony and the radar is operated against live targets over the sea test range. ④This hybrid simulation system consists of a Sigma V digital computer, a COMCOR 5000, and a COMCOR 500 analog computer with a COMCOR 5100 inter-communication unit. The entire F-14A Phoenix flight operation can be simulated by this system in combination with signal-environment generators, a Phoenix missile, an F-14A aircraft missile-control system, and the data-acquisition system. ⑤This six-degree-of-freedom helicopter-cockpit simulator allows system testing without launching aircraft. It is currently being used as a moving platform for tests on detection or acquisition of targets by laser. ⑥The missile control officer trainer is used in training personnel in use of controls for the Phoenix missile system and in interpreting instrument readings. The panel at the right monitors actions of the control officer, and that at the left controls parameters of the problem.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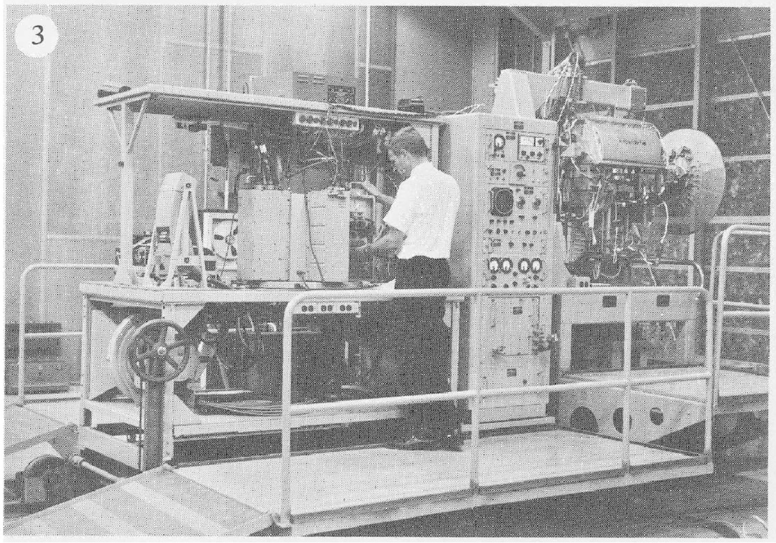
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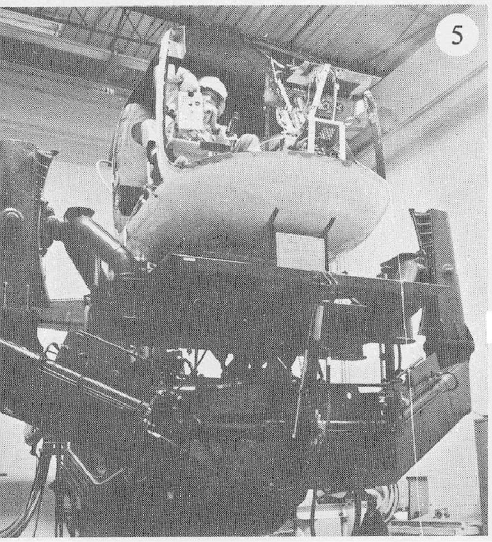

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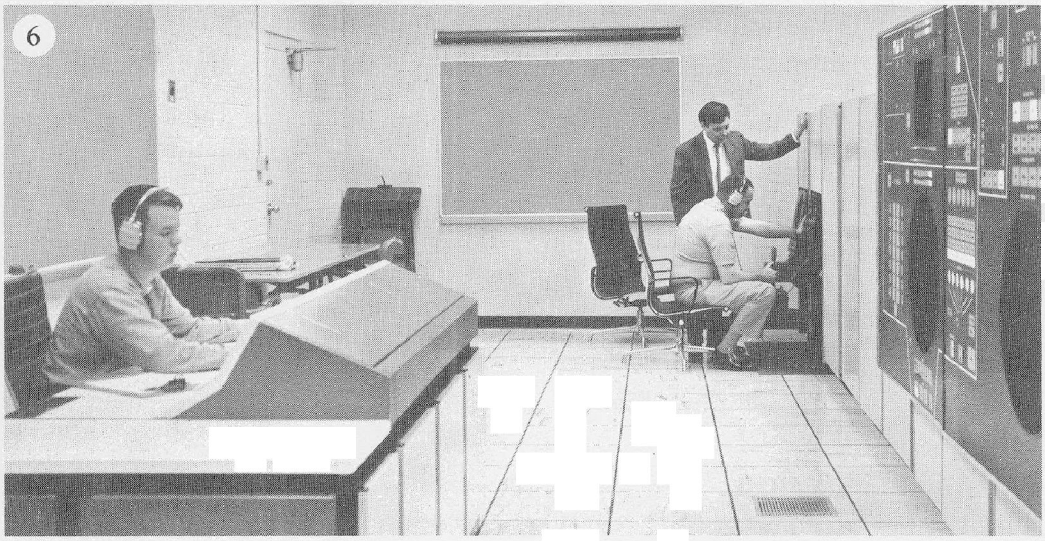

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